TUBE COLLECTOR

TUBE COLLECTORS ASSOCIATION

"HISTORY • PRESERVATION • APPLICATION"

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TUBE COLLECTOR

TUBE COLLECTORS ASSOCIATION, INC.

PO Box 636, Ashland, OR 97520, USA

The Tube Collectors Association is a nonprofit, noncommercial group of individuals active in the history, preservation, and use of electron-tube technology. *Tube Collector*, its bulletin, appears six times per year.

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FRONT COVER: Drop in a penny and pull the lever . . . perhaps a Telefunken smooth-plate 12AX7 will come out. Or maybe not. Dispenser from the Columbus Vending Company of Columbus, Ohio. *Sibley collection.*

REAR COVER: Cover of catalog for Pope tubes, a brand of Philips Gloeilampenfabrieken, Eindhoven, Netherlands.. *Image by courtesy of Larry Daniel.*

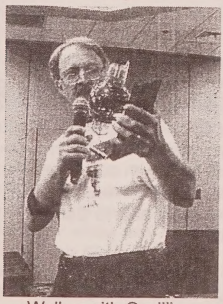
MICROPHONICS FROM THE EDITOR

TCA 2018 MEMBER MEET

Out 2018 member event took place on June 14 as an opener for the Mid-Atlantic Antique Radio Club RADIOACTIVITY meet in Beltsville, Maryland.

Your editor summarized the "state of the Association." For later statistics on membership, see the 2018 directory following page 16.) A matter of considerable pride is the high level of Canadian / foreign membership, at 18%. (By contrast, a major US wireless association, in its peak years, achieved only 8%.)

John Walker demonstrated some rare-and-precious tubes from his collection: a Signal Corps VT-15, a Western Electric 102D with plate and grid "horns," a half-kilowatt De Forest Oscillion, and - perhaps the rarest of all - a Western Electric mercury-arc repeater element of the type invented by their developer H. D. Arnold and tried out on the 1915 transcontinental line, but handily superseded by vacuum tubes with their stable gain and low noise..



Walker with Oscillion

Sibley passed around a display board showing a dozen GE ceramic planar triodes (see Page 16). He gave a slide talk on Charles Eisler and his Eisler Engineering Company, the major source of tube-making supplies and equipment for the independent tube industry during its prime.

Ed Lyon demonstrated a spiffy three-tube '20s broadcast receiver, developed and marketed by the Lowell-and-Dunmore combination of AC receiver-patent fame, using Radio Audion company triodes. There are lots of these RAC-3 tubes around, but "never seen" in a radio.

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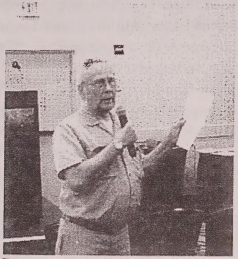
Paul "Transconductance" Hart gave a preview of the talk on tube-testing, which he delivered to the MAARC event the next day. He addressed the latest discoveries

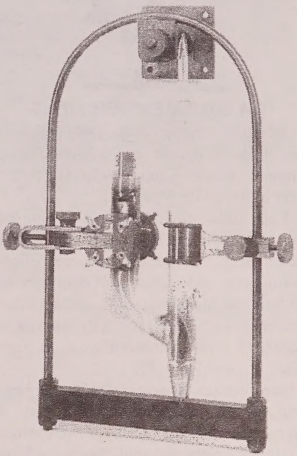
on the well reputed but inconsistent Hickok line of testers based on its "genius" circuit.



Paul Hart gives the latest discoveries on Hickok testers.

Later in the day Sibley gave a general session on tubes, with special emphasis on Westinghouse products, in support of MAARC's special theme for this year. (Frank Conrad, builder of .W.'s pioneer radio station KDKA, was a tube collector.!) MAARC held a special tube-and-literature auction offering material from the estate of Ted Hannah. It included the Collins 100A and 100D gridless oscillator tubes of the early '30s, an "ocean" of new-in-box 201As, the rare Gernsback radio-repair binders, highly displayable radio-related posters, etc..

We are most appreciative of MAARC's opportunity for mutual support.



For the record: a Western Electric photo of the Arnold mercury-arc repeater element, of the style exhibited by Walker, in its mounting. Its beam-deflection magnet is at center left.

Life In the Post-Scientific Era

NO MORE LUMPS 'N LINES!

The healing magic of magnets is built right in to this unique magnetized underwear. Many believe that magnets improve circulation, ease pain and increase the metabolism. These amazing panties are by the fastest, easiest way to instantly appear 10, 15, even 20 pounds slimmer . . . without surgery or strenuous dieting. Smooths the silhouette and caresses your body with soft, breathable imported Nylon/Spandex. FREE SHIPPING AND HANDLING when ordering 2 or more plus a FREE SURPRISE GIFT! U. S. orders only. Cannot ship to Canada. Satisfaction Guaranteed or Return for Your Money Back.

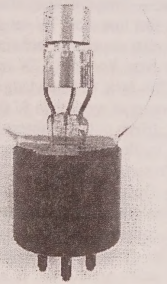
TWO WECo "WHATZITs"

We have here two unknown Western Electric tubes. Neither is recorded in Bernie Magers' 75 Years of Western Electric Tube Manufacturing, nor in Jim Cross' comprehensive Complete Western Electric Vacuum Tube Library DVD-ROM.

"In the box": tubes of two vintages.
Photo: Frank Hagenbuch

The first is the 205F FAST. This is variant of the well known 205F power triode. The FASTness in unknown. One speculation is that it's a quick-heating version, possibly used in push-to-talk "flying telephone" aircraft transmitters like the 8A, 9C, or 13C. These were designed for 205Ds, and therefore could be equipped with 205Fss. But the FAST version has been found in movie-theater spares.

WE made no secret about the FAST feature. The cartons are printed with the word, in either full-size or reduced type; the tubes are ink-branded FAST, the term is "etched" on the dome o the tube, and the little instruction slip packed with the tube is ink-stamped similarly in red.



D-85789
Photo: choptankriver

The other oddity, a recent eBay posting, is the D-85789. This is in "tennis-ball" format. The mount comprises two nickel cylinders surrounding a smaller cylinder, one above the other. There is no hint of a filament or grid. The suspicion is that it's a two-wire surge (lightning) suppressor, after the model of the three-element VAC-M "lightning arrester" of the '20s, or the Westinghouse KX-642 three-electrode spark-gap tube. "New to science."

BEWARE OF THE TV REPAIR RACKETS

Louis Lefkowitz (Attorney General, State of New York)
Reprinted from *TV Guide* by *Sylvania News*, Nov.-Dec. 1960

"Enjoy movie-clear reception even on old sets ... The Radarex-Tenna adds new life and sparkle to the weakest channels by turning house wiring into a 500-foot TV antenna for only $3.95."

More than $100,000 was spent by viewers who responded to this widely publicized advertisement.

Was the Radarex-Tenna the cure for foggy television reception? Far from it. Unprejudiced testing showed reception was worse in many cases. In fact, the purchasers of the device risked electric shock when they placed it in a wall socket.

The advertisement was one of the countless schemes used to defraud American television set owners of millions of dollars each year. These frauds involve the sale of gadgets similar to Radarex-Tenna, fraudulent advertising, overcharging on repairs,

false labeling of tubes and other gimmicks.

America has the finest and most reputable engineers, technicians, repairmen and servicemen in the world. But there will always be business sharpshooters. In the television repair and supply field they are like the individuals who sold the Radarex-Tenna — always willing to take advantage of the fact that most TV set owners are not electronics experts or technicians.

One New York City TV repair firm utilized this lack of knowledge to victimize set owners of more than $1,000,000 before being driven out of business in a combined effort by the Bureau of Consumers Frauds and Protection of the New York State Attorney General's Office, consumers, reputable dealers and leading manufacturers.

The company's operation was characterized by "bait" advertising followed by sharp sales practices. It advertised that TV repair cost could be "budgeted" with payments as little as 50 cents a week. Happy customers were assured no repairs would be made without their approval.

Once the sets were in its shop, however, the firm notified the customer that a new picture tube costing $40 was required. The company refused to return a set until a down-payment as high as $35 was made to cover the cost of tubes and service. The hapless customer had no alternative but to pay the excessive charge — often without knowing if the new tube was needed.

Another firm, using similar tactics, accumulated more than $500,000 worth of television sets because customers refused or were unable to pay for repairs they never agreed to have made.

Perhaps the greatest outrage in the television repair and supply field is the outright forgery committed by a few concerns which remove manufacturers' markings from inferior tubes and substitute the trademarks and labels of leading brand-name manufacturers. In New York State, the Bureau of Consumer Frauds and Protection, as well as local district attorneys, have moved against these operators. Indictments were handed down against 13 firms.

How widespread is this practice? The Electronic Industries Association has estimated that the placing of counterfeit radio and television tubes on the market has resulted in a loss of more than $100,000,000 to the industry. No one can estimate how many more millions have been lost by the consumer.

The tube industry is a billion-dollar-a-year business. Legitimate elements in the business have made sincere efforts to eliminate abuses, which hurt the reputable dealer and supplier as well as the consumer.

In New York State, fraudulent and forged labeling is the target of a new law enacted by the 1960 Legislature. This law requires that secondhand, rebuilt or reconditioned tubes be appropriately labeled. It also provides that servicemen installing secondhand or rebuilt tubes make this information available to the customer even though the container of the tubes may bear such disclosure. The law also is designed to eliminate deceptive guarantees, fictitious price reductions and unauthorized use of well-known brand names on inferior products.

Legislation and law enforcement cannot do the job alone. The public is the first line of defense against fraudulent and misleading practices.

By using the following suggestions as a guide, the television set owner can help hold the line against the scheming operator and avoid the exasperation of being victimized.

- Don't permit your set to be taken from your home for repairs without receiving a written estimate of the cost of repairs.
- Obtain written assurance that no additional repairs will be made unless you agree and that if you do not wish the "extra" repairs, the set will be returned immediately.
- Never sign a contract without reading it carefully.
- Never sign a repair contract which contains blank spaces. Hundreds are victimized in this way every day.
- Never sign a statement that the work is done when it is not. You may have to pay for an unfinished job.
- When dealing with an unknown repair service, check with your chamber of commerce, better business bureau or repairmen's association.

WHAT IS A GOOD TUBE?

Excerpted from an article in Radio Broadcast, *March 1929*

Three years ago a series of articles was published in *RADIO BROADCAST* as a result of a serious investigation of the characteristics of the radio vacuum tubes then on the market. Nearly one hundred tube manufacturers sent samples of their products to the Laboratory to be tested. Many of these manufacturers have since demonstrated the fact that they had no business in the tube market - their names are forgotten. At that time, radio listeners and dealers did not have the means of finding out the characteristics of the tubes, and probably knew little about what the characteristics meant if they had been able to obtain them. No one knew how long a tube was supposed to last, least of all the ultimate user. Then the market for radio receivers was rising rapidly, but was still small. And so the data collected in the Laboratory and published in this magazine not only gave the possible users an idea of how to judge good tubes, but how to use them intelligently, and – if they desired – simple methods of measuring their characteristics as well.

Today the picture is different. There are perhaps a dozen reputable manufacturers of tubes for receivers and power apparatus – and yet the market for tubes has increased to a degree never dreamed of by the forefathers of radio. The tubes made by these manufacturers are more uniform in their characteristics, have longer lives, and look and act more like their brothers from other factories. The tube business is "shaking down;" it is becoming more a matter of engineering and less of cut-and-try. The names of tube manufacturers we still see on tube cartons are the names of people who have learned by experience how to make a good tube.

Now the question is, "What is a good tube?"

Answering the question "What is a good tube?" involves two factors, the electrical characteristics of the tube and the factor of economics. How long will the tube last?

The characteristics of general- and special-purpose tubes have undergone no radical changes in a year or more. Whether or not this is fortunate, we are not prepared to state. It is true that every reputable manufacturer who is interested in his future is doing his best to build good tubes, tubes whose characteristics are good when the user purchases them, and good for a long time afterward. The uniformity in the characteristics, as shown by comparing the data in the following pages, was not true three years ago. Then there was a wide disparity between the characteristics of one tube as compared with a similar type made in another plant. Now a 201A-type tube is a 201A type tube no matter who makes it.

STANDARD TUBE TYPES ARE SIMILAR

Differences among the products of the tube manufacturers are differences of construction, differences of material, differences of packing for shipment, etc. The electrical characteristics are much the same no matter what the name of the tube. But the differences in mechanical construction, in pumping, and in the choice of materials used are the differences that determine the second criterion by which one may judge a good tube.

The first factor, the electrical characteristics of tubes, involves the manufacturer alone. The second involves both the manufacturer and the user. The best of tubes will blow up if the proper wires of the receiver are crossed, or if a screw driver in the experimenter's or engineer's laboratory or in the serviceman's shop falls into the power supply by accident. The best tube will have short life if its filament or plate is overloaded with voltage. The electrons which make the radio wheels go round are tireless workers, but their supply is limited. The best tube will suffer with fatigue if it is forced to work under condi-

tions for which it was not designed.

Generally speaking, tubes from one of the manufacturers represented in the following pages should last as long as from any other and, although there may have been a time when manufacturers deplored the fact that their tubes lasted too long, it is true now that every manufacturer must make his tubes as good as is possible. Competition takes care of that.

And yet all the responsibility for long tube life does not rest with the manufacturer. The serviceman who recommends the tube, the dealer who sells it, and the user who employs it must share responsibility. The dealer-serviceman's share is particular for it is he who knows whether or not the set-owner is operating the tubes of his set at voltages recommended by the manufacturer. It is he who must tell the user not to raise the filament and plate voltages until the last "ounce" of signal strength or "DX: is extracted from his radio.

IMPORTANCE OF CORRECT VOLTAGE

A tube manufacturer is much more familiar with his product than anyone else can be, and when the tube manufacturer sets the voltage limits which his tubes can stand, the user has no right to assume a new of set ratings for himself and to expect the manufacturer to replace tubes which seem to have premature failure of emission. In other words, if the correct filament or heater voltage of a certain tube is 2.5 volts, the experimenter should not use 3.0 volts nor should he use 2.0 volts and expect long tube life.

Let us consider the case of a power tube, a full-wave filament rectifier, for example. It seems natural to suppose that it will last much longer if we don't overload the filament and such is true. But let us reduce the voltage across the filament, burn it at a lower temperature, and see what happens. All tubes lose emission as they get old. Rectifier tubes have a certain lower emission limit beyond which they cannot hope to keep up with the drain of electrons imposed not only by the receiver, but by the filter and voltage divider as well. Once the tube emi5sion falls below this figure, the voltages supplied to a receiver begin to fall, a. c. hum begins to come up – because the waveform of the rectified current is no longer halves of sine waves, but has a flat-topped form, hard to filter. – and the regulation is bad because of the increase in effective resistance of the rectifier and hence of the plate-voltage supply system.

When such a tube is operated below its rated temperature, the supply of electrons is not as great as when the temperature is raised. This means that the useful life of the tube is decreased, because the lower limit in emission is reached sooner. The tube is still good, and probably would continue to supply plenty of voltage if its temperature were increased – but the only safe and economical method is to supply the heating voltage that the tube needs throughout its life.

How can the user tell a good tube from a bad one? He must first of all buy a tube whose name is known to him. It is safe to state that a purchaser of tubes gets exactly what he pays for, and if he wants freedom from replacement worries, he should purchase a tube whose name is one he is sure of, one that is nationally advertised and sold, and backed by a manufacturer who has a reputation for making good products out of glass, nickel, and electrons.

A purchaser cannot tell by looking at a tube whether it is good or not. He must rely either on the tube maker's reputation or upon the advice of his dealer or serviceman. It is certain that the latter must not trick the former into buying "just as good" products on the supposition that they can get away with it. A dealer who has a monopoly on the radio sales in his community might sell the tubes that cost the least and had the shortest life, but he could be sure that someone would soon furnish his customers with better tubes – even at a higher price, and that his short-sighted policy would get its merited result.

There is a practice in "gyp town" of

showing a prospective customer how good a tube is by stepping on a foot switch which boosts the plate voltage while the tube is being tested. Of course, the plate current will be high, and the customer thinks is he receiving a high-emission product. The chances are he is getting somebody's shrinkage.

The answer is to buy tubes from well-known dealers, who safeguard their customers as well as themselves. If tubes get weak, as indicated on a reputable dealer's or service organization's tester, within a short time, look at the name. In the majority of cases it is one you never heard of.

From the dealer's standpoint, the rules for successful tube sales are but three – 1. Sell only well-known tubes, 2. Insist that your serviceman installs these tubes so that the voltage will be correct, 3. Make sure that the purchaser operates the tubes according to the conditions the manufacturer recommends.

From the user's standpoint, there are three rules, 1. Buy a known tube, 2. Buy it from a well-known dealer. 3. Operate this tube at correct voltages.

A NOTE ON RING GETTERS

We had coverage on the various commercial getter assemblies in "modern" tubes, in Abel Santoro's article in the February 2017 issue. Here's a bit of internal RCA traffic regarding getters used in their production of tubes for military use. It may inform the ongoing concern (or obsession) among tube users as to the types of getters in tubes offered for sale. It comes from the Dowd-RCA Archive, a holding of the AWA Museum. - Ed.

INTERNAL CORRESPONDENCE

To: M. H. Spivack — Location Newark — Date May 12, 1964
From R. E. Brown — Location Harrison 22-3

Subject Qualification Approval for Use of Ring Getter as Alternative on JAN Approval Types

The vendor no longer wishes s to manufacture the loop "KIC" getter for the following types:

83	26A7GT
6N7GT	1629
6U5	5651WA

As a substitute, RCA would like to standardize the ring getter. This presents a problem with the JAN approved versions of these types. Ring getters are being used successfully in several other JAN types at present. Factors contributing to the success of ring getters include its ease of flashing, and highly directional flash. Ease of flashing results in a more uniform flash, and on occasion, a reduction in gas due to over-heating of other tube elements where the getter must be mounted close to the cage. With a highly directional flash inter-electrode leakage is frequently kept under better control since less active material is reflected onto the cage and in particular the mica surface where leakage is likely to occur.

Because of the present emergency, a successful history, and the inherent advantages of this change, it is requested that we obtain approval (where necessary) for the use of the ring getter on these types without the usual submission of a formal report.

/s/
R. E. Brown
Receiving Tube Application Lab.

REB / jc
Cc: W. E. Babcock F. G. Foerster
]N. C. Fanarjian M. J. Sarulloo
F. J. Feyder

PHILCO SERVICEMAN
Circulation, Over 30,000 Copies Monthly
RADIO · MANUFACTURERS · SERVICE · NEWS
SEPTEMBER, 1935

Some outraged, shrill invective from the Samoff-haters in Philadelphia . . . - Ed.

PHILCO AND METAL TUBES

All Philco 1936 receivers, of course, are equipped with Philco high-efficiency glass tubes. In view of the current publicity on metal tubes, it will be of interest to the serviceman to learn the reason why PHILCO employs glass tubes in the new 1936 line of receivers.

MANY TECHNICAL PROBLEMS

The technique and manufacture of glass tubes have improved considerably in the last few years with the result that tube rejections in PHILCO receivers now amount to less than 0.6 per cent. Tube manufacture, however, is still an art, and every new tube type, whether it be glass or metal, presents technical problems which may require weeks and sometimes months of patient application to correct. Many servicemen will recall the serious performance troubles coincident with the introduction of Types 99, 27 and 24. Metal tubes have provided new and immeasurably more complicated problems, many of which are difficult of solution. It is not difficult to picture the situation presented by the entirely new processes involved, not alone on one type of tube, but with the whole group of metal tubes. Factory difficulties on metal tubes have not only seriously restricted the production output, but the types of troubles encountered result in poorer performance, even worse than had been predicted from a study of the structure and electrical characteristics.

CAUSES OF FIELD TROUBLES

Such metal tube difficulties as air leakage, internal deposits of welding flash causing electrical leakage and noise, rusting of steel parts, shorts from lead wire to shell, grid current due to air leakage and grid current due to evolution of gas from metal parts are serious problems which may mean field trouble and plenty of it until corrections are discovered and applied. PHILCO saw and predicted many such difficulties for metal tubes and the decision to remain with glass tubes for 1936 resulted.

It has been claimed that the performance to be expected from metal tubes would be superior to glass. Actually the reverse is true.

SIZE NOT A FACTOR

The size of metal tubes at first appears to be an acvantage, but little if any space saving can be effected since coils must be as far from heat-radiating surfaces as possible, in order to reduce the frequency drift on the oscillator responsible for a type of fading noticeable on short waves. To approximate the performance obtainable from glass tubes, additional metal tubes are required, still further offsetting any possibility of space saving and adding to tube cost.

Metal tube life is as yet an uncertain factor, with field reports of many early failures in sample lots and considerable uncertainty regarding maintenance of quality of tubes kept in stock for even short periods.

The question of tube cost is of vital interest to all of us. Present list prices of metal tubes are high. More metal tubes are required to equal the performance obtainable from PHILCO glass tubes. Poor performance per tube, high cost of metal tubes, production difficulties associated with any new type tube and lack of confidence in tubes kept in stock are the major reasons why PHILCO has adhered to glass tubes. Experience has shown that PHILCO high-efficiency tubes provide superlative performance, stand up in service and can be purchased at reasonable prices.

LOW-VOLTAGE RECEIVING TUBES

T. M. Cunningham
Receiving Tube Engineering, RCA Electron Tube Division, Harrison, N. J.
RCA Engineer, Aug.-Sept. 1958

THIS PAPER describes the major considerations involved in the design of tubes intended for low-voltage applications. The development of electron tubes designed to operate in the range from 10 to 20 volts has been stimulated by the possibility of their use in conjunction with semiconductor devices in automobile receivers.

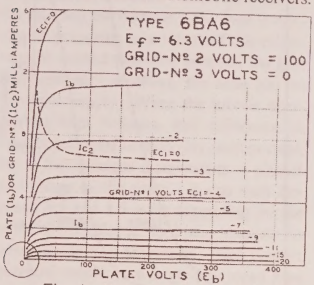


Fig. 1 - Plate characteristics curve of 6BA6

Hybrid radio receivers utilize transistors in the audio-output stage and electron tubes in all other stages, and are operated directly from the 12.6-volt electrical supply system of the automobile. This type of receiver can deliver two to five watts to a speaker without the use of a vibrator and high-voltage supply.

The economic attractions of the hybrid design have resulted in the development of a line of receiving tubes intended specifically for automobile receivers. However, these tubes should also be considered in the design of future portable receivers, portable record players, and portable television where the ability of the semiconductor device to provide a large power output at low voltages and the relative low cost of the receiving tube can be combined to advantage.

REASONS FOR LOW-VOLTAGE TYPES

The advent of the low-voltage receiving types may have raised questions in the mind of the set designer, such as, "Why develop new tubes to operate from low-voltage supply? Why not, except where special problems arise, employ existing tubes and operate them in the low-voltage region."

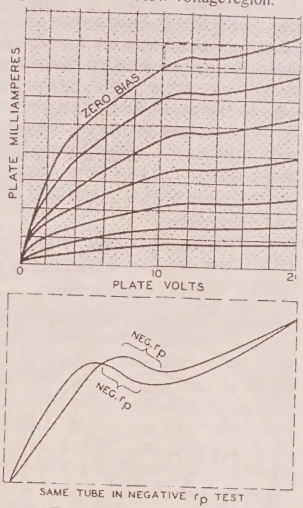


Fig. 2 - Negative dynamic plate resistance (r_p)

Actually, it is possible to use existing tube types and operate them in the low-voltage region in some cases. For example, twin-diode triodes for use as AVC detectors and audio-frequency amplifiers can be used in low-voltage radio receivers with no essential changes in tube design. However, it is necessary to redefine the electrical characteristics of the tube for operation in the low-voltage region and to

provide additional production controls.

Fig. 1 shows the E_b-I_b curve of the familiar 6BA6 or 12BA6 pentode amplifier over the normal voltage range. The small section of the operating range which is important in low-voltage applications is shown by the circled portion. Thus, though it may be possible to use a conventional tube in the low-voltage region, the tests and characteristics control considerations of the tube have to be redefined for operation in this region.

The new tube designs that are required for low-voltage operation are seemingly very simple and, in effect, involve nothing more than modification of existing tube designs or design principles. Some of the reasons low-voltage applications require new tube designs are the following:

1. Tubes intended for this type of operation must have uniform characteristics over a relatively wide range of operation and reasonably low and controlled signal-grid contact potential.

2 Low voltage tubes must be specially designed and processed in manufacture to suppress secondary emission effects.

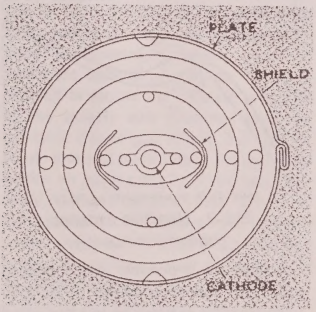


Fig. 3 - Cross-sectional view of 6BE6 and 12BE6

3 Some applications require new radio-frequency amplifiers having very remote-cutoff characteristic to prevent overload and cross-modulation distortion with large signal and voltage variations.

4. Higher stage gain is required in converter and voltage amplifier stages than that afforded by conventional tubes.

5. Audio power amplifiers having sufficient power output and power sensitivity to drive semiconductor-device output stages are required.

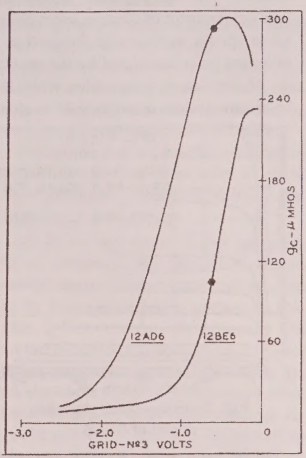


Fig. 4 - Comparison of electrical characteristics of 12BE6 and 12AD6

SPECIAL PROBLEMS

The special problems associated with low voltage receiving tubes of primary importance are those of contact potential and the so-called "ten-volt effects." However, before these special problems are considered, the increased importance in low-voltage operation of the general problem of supply-voltage variation should he noted. For example, a variation of one volt at ten-volt operation represents a much larger percentage of the total than at 100-volt operation. In an automobile, the nominal regulator voltage in some cases is 14.4 volts for 90 per cent of the time, and has a low of 10.0 volts or a high of 16.0 volts for 10 per cent of the time. Under these conditions, tubes are made to operate over a range of plus or minus 23 per cent of the

mean value. In amplifier stages, the gain must remain relatively constant over the entire range of operation. Therefore, the tube characteristics at the low and high ends of the operating range are of the utmost importance in equipment design.

One of the major problems in the development of tubes for low-voltage operation in receivers was learning how to process tubes having low contact potential. When no AVC is applied, the control-grid operating point is determined by the bias developed across a resistor connected between the grid and the cathode. The bias is developed primarily as a result of the difference in contact potential between the grid and cathode. In effect, the tube has its own bias supply. When the tube is operated at high voltages, this difference in contact potential is relatively unimportant, but at low voltages it represents a sizable percentage of the plate. It can vary between 0.5 and 1.5 volts depending on the materials employed and the manner in which the tube is processed. High contact potential results in a large developed bias which can cause low gain, particularly in converter stages.

Contact potential in tubes is due to the difference between the work functions of the cathode and of the control grid. During tube activation the control grid becomes progressively more electropositive as barium metal is evaporated from the cathode and deposited on the grid. It has been determined that minute surface contaminations exert a profound effect on the work function and, therefore, on the contact potential. In low-voltage receiving tubes, contact potential is controlled by the judicious selection of grid materials and by special tube processing methods. In practice, the tube is processed at a very high heater voltage for a very short time at the end of activation to apply the correct amount of barium on a clean signal-grid surface.

Two "ten-volt effect" problems have been experienced in the development of low-voltage receiving tubes. One is the "ten-volt slump" effect, and the other is the "high-speed ten-volt effect." Both problems have received attention in the RCA Laboratories in Princeton by Nergaard and Matheson [1]. The ten-volt slump effect is a result of oxygen released by contaminated electrodes when they are bombarded by 10-volt electrons. The bombardment of metal oxides by 10-volt electrons releases oxygen which migrates to the cathode. The cathode is particularly vulnerable to oxygen poisoning and therefore the emission can be decreased and the coating resistance increased.

The 10-volt slump effect has not been a problem of any practical concern in conventional tubes because of the use of oxide free parts. However, high-speed ten-volt effects have been very evident in tubes designed for low-voltage operation. The high-speed ten-volt effect can cause objectionable irregularity in the Eb-Ib curves for tubes operating in the ten-volt region. An example of this irregularity, which is commonly called negative dynamic plate resistance, is shown in Fig. 2. Uncontrolled "kinks" in the tube characteristics curves can of course result in signal instability and signal distortion in receiver applications. This effect can occur in all types of receiving tubes that operate in the ten-volt region, whether they be diodes, triodes, tetrodes, pentodes, or heptodes. Negative rp has been observed to occur between 8 to 14 volts. Dr. Nergaard and Mr. Matheson explain the effect as follows:

> In summary, the small, stable deviations from the 3/2 law found in tubes with oxide cathodes are due to a layer of extraneous material on the anode. Secondary electrons from this layer increase the charge in the interelectrode space, depress the potential minimum, and reduce the space current below that predicted by the 3/2 law. Evaporation experiments and secondary yield data indicate that the layer consists of barium oxide evaporated from the cathode. The apparent sudden onset of the effect is then explained by the rapid rise of secondary yield of barium oxide in the neighborhood of 10 volts [1].

In practice, the spray of secondary electrons is reduced by making the plate surface rough (for example, by the use of a carbonized plate material) and by keeping the barium oxide content to a minimum through the judicious use of tube activation schedules. In the design of tubes which employ suppressor grids, careful consideration must be given to the region of the tube between the screen grid and the plate in order to minimize the possibility of a negative dynamic plate-resistance condition. Obviously, this problem can be avoided if the equipment designer centers the tube operating region well away from the ten-volt region.

THEORETICAL DESIGN CONSIDERATIONS

Before any actual tube design problems are considered, an investigation of the application to low-voltage tubes of one of the formulas employed to transpose electrical requirements into tube design parameters may help to illustrate some of the problems that are peculiar to the design of these tubes.

The formula shown below is a derivative of the well known Childs-Langmuir 3/2 law for plate current and is used to determine the signal-grid-to-plate trans-conductance of a triode.

$$g_m = \frac{3.51 \times 10^{-6} Ak \left(\frac{E_b}{\mu} + E_c + \varepsilon \right)^{1/2}}{d_{cg}^2 \left[1 + \frac{1}{\mu} \left(\frac{d_{cp}}{d_{cg}} \right)^{4/3} \right]^{3/2}}$$

In this equation, A_k is the cathode area, d_{cg} is the spacing between grid and cathode, and d_{cp} is the spacing between plate and cathode.

As can be seen, if the value of the amplification factor is greater than the plate voltage (which is not too uncommon at low-voltage conditions), the expression for gm becomes imaginary, a so-called "unreal number." To allow for this situation, a correction factor, ϵ, must be determined and added to the quantity inside the bracket in order to obtain reasonably close calculations. Electrons usually have velocities below 0.5 volt when leaving the cathode. The initial velocity of the electrons determines the potential minimum point, or, in other words, the position of the virtual cathode. Because the electron velocity influences the apparent tube geometry, its combined effect adds to the electrode voltage and is accounted for by the correction factor.

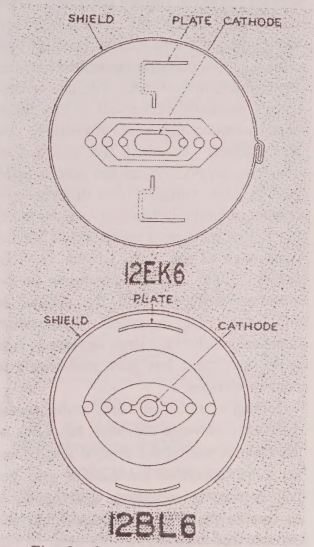


Fig. 6 - Cross-sectional view of 12BL6 and 12EK6

The pentode transconductance can be determined from the formula for triode g_m if the screen grid is considered as the plate, and the screen grid is considered as the plate, and the value derived thereby is multiplied by the ratio of plate to screen current.

MAJOR TUBE DESIGN CONSIDERATIONS

In the remainder of this paper, the design and processing of several low-voltage types used as converters, i-f and r-f voltage amplifiers, and audio-power amplifiers

will he discussed. Because most of the work to date has been done expressly for the automobile receiver manufacturer, the design considerations that are discussed apply, for the most part, to amplitude-modulated receivers operated in the broadcast band.

1. Converters

Fig. 3 shows the physical layout of the 6BE6 and 12BE6 pentagrid converters which are used in practically all amplitude-modulated receivers. Fig. 4 shows the electrical characteristics of the 12BE6 as compared to those of a new low-voltage tube, type 12AD6. When the 12AD6 is operated normally, 12.6 volts is applied to the grid No. 2, grid No. 4, and the plate. The circled points shown on the curves refer to the operating point as established for each tube by the bias developed across a 2.2-megohm grid resistor. The conversion transconductance, and therefore the gain of the 12AD6, is considerably higher than that of the 12BE6 in low-voltage operation. A conversion transconductance as high as that of the type 12AD6 can be obtained by the following modifications of the 12BE6: 1) lower turns per inch (or higher pitch) of grid No. 1, the control grid of the oscillator section, in order to increase the oscillator plate current and transconductance; 2) a 40-turns-per-inch constant pitch instead of a variable pitch for grid No. 3 in order to optimize the g_c at the developed bias point; 3) smaller mean outside dimensions for grids No. 2 and No. 4 in order to increase the plate current and g_c under low-voltage operating conditions.

The manufacture of this type has been particularly difficult. Contamination of the signal grid by barium from the cathode is necessary in order to keep the contact potential down. An excess amount of barium causes contamination of the plate by free barium and barium oxide, and results in problems due to negative dynamic plate resistance. The problem can be avoided only by judicious selection of plate material and by proper activation procedures.

2. R-F and i-F Voltage Amplifiers

Because of the automatic-gain-control problem, receivers which operate from low-voltage supplies often require r-f amplifiers having a "super-remote" cutoff characteristic to reduce the possibility of overload and distortion. A high-gain antenna input system can cause signal voltages to be quite large at the r-f amplifier. This condition is apt to occur in the vicinity of broadcast stations. In fact, the amplified signal voltage can be equal to the plate voltage. In some cases, the agc problem is solved by the use of a pentagrid converter having agc on grid No. 1 and the signal on grid No. 3. However, the more recent pentode r-f amplifiers for 12-volt operation have a cutoff point of between -6 volts and -19 volts instead of a cutoff point of -4 volts such as the 12BA6 has.

The popular high-transconductance 12BA6 is, of course, the general purpose high-gain voltage amplifier that is used at normal voltages in AM as well as FM and television receivers. Because it was originally designed for FM and television applications, the capacitances, especially the grid-plate capacitance, are quite low. Tubes which are operated in the broadcast band do not necessarily have to operate with high load impedances or very low grid-cathode capacitances in order to provide satisfactory stage gains.

Fig. 5 shows a cross-sectional view of two r-f and i-f pentodes specifically designed for 12.6-volt operation, the 12BL6 and 12EK6. Table I shows the important electrical characteristics associated with each design. As it can be seen, both dynamic plate resistance and grid-plate capacitance are sacrificed in the higher transconductance versions. The design of the 12BL6 is essentially the same as that of the 12BA6 except that the control grid and screen grid have been modified to give a 50 per cent increase in gm at low-voltage operation. Without any detailed explanation, it can be seen that the progressively higher transconductance tubes generally

are obtained by increasing the active area of the cathode and by decreasing the electrode spacings. However, a grid No. 1-to cathode spacing that is less that 5 mils can cause "noise-when-tapped" quality problems in mobile or portable equipment.

The electrical characteristics of the tubes listed in Table I satisfy both low-load-impedance and high-load-impedance circuit requirements. Although type 12EK6 has a very low dynamic plate resistance, it is used in some applications where the inductance of the plate resonant circuit is tapped. The tank inductance becomes an auto-transformer which, when tied into a diode circuit, develops a larger agc voltage than can be obtained otherwise. In addition to allowing close spacings without excessively increasing grid-plate capacitance, the odd shape of the 12EK6 plate permits the use of 12BA6 shielding and thereby saves parts-tooling costs. An obvious contribution would be the design of a tube having high transconductance, high dynamic plate resistance, and reasonably low grid-plate capacitance in order to satisfy the requirements of low-impedance and high-impedance circuits with one tube design.

3. Audio Power Amplifiers

For any audio-power-amplifier work that is to be done by tubes, the beam power tube is usually considered first. When operated at a plate voltage of 12.6 volts, practically all of the conventional high-voltage beam power tubes deliver less than 10 milliwatts power output into an optimized load impedance. The 6AU5GT delivers approximately 7.5 milliwatts and the 6AQ5 delivers approximattely 2.0 milliwatts at 12.6-volt operation. For low-voltage operation, the space-charge tetrode invented by Irving Langmuir in 1913 can deliver more power output than a beam power pentode. The type 12K5, a tetrode of the space-charge type developed especially for new automobile radio receivers, can deliver an output of approximately, 40 milliwatts. However, in applications where power sensitivity is important, the beam power tube is more sensitive than the space-charge tetrode at output levels in the order of 15 milliwatts.

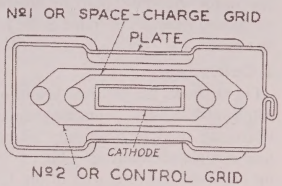


Fig. 6 - Cross-sectional view of 12K5

Fig. 6 shows a cross-sectional view of a space-charge tetrode, the 12K5. In the operation of this tube, the total positive potential supplied by the automobile electrical system is applied to grid No. 1, the space-charge grid. Between grid No. 1 and the plate, the tube operates as if it were a triode (grid No. 2 acts as the control grid). A Langmuir space-charge grid is inserted between the control grid and the cathode to increase the flow of electrons from the cathode. The basic reason for this arrangement is that the field due to the space charge near the cathode is partially neutralized by the field of the positive grid. Thus, a larger percentage of the total number of electrons emitted by the cathode is utilized in space current, and the "virtual cathode" in effect is transferred from a space-charge cloud or sheath surrounding the cathode to a considerably larger space-charge cloud or sheath surrounding grid No. 1. The position of this virtual cathode surrounding grid No. 1 is determined by the plate and grid No. 2 potentials.

TABLE I
Electrical Characteristics of Low-Voltage R-F and I-F Amplifiers

	12BL6	12EK6	
E_f	12.6	12.6	volts
E_{bb}	12.6	12.6	volts
$E_{c_1c_2}$	12.6	12.6	volts
i_f	150	200	milliamperes
g_m	1350	4200	micromhos
r_p	500,000	40,000	ohms
I_b	1.35	4.4	milliamperes
I_{c_2}	0.50	2.0	milliamperes
E_{c_1} (at 10 micromhos)	−6.0	−4	volts
C_{gp} (maximum)	0.006	0.032	microfarads
R_{g_1}	2.2	2.2	megohms

Because of this operation, the total density of the space charge is reduced, but the effective cathode area is greatly increased. When 12.6 volts is applied to the space-charge grid, this grid draws approximately 80 milliamperes, which amounts to about 1-watt dissipation for grid No. 1. Although this current is wasted space current so far as useful operation of the tube is concerned, the emission capabilities of the cathode are such that sufficient plate current flows without saturation. Moreover, the perveance of the tube is greatly increased by the use of a space-charge grid, and the internal plate impedance is greatly decreased. This type of operation, therefore, accounts for the relatively high transconductance and power output of the 12K5.

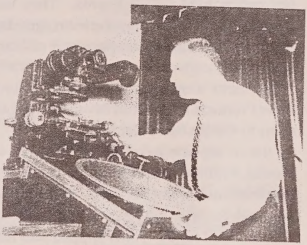
In the 1930s, this type of operation was considered wasteful of space current at high operating potentials, and therefore discarded in favor of beam power tubes. For power amplifiers having high voltage readily available, it was found more economical and efficient to meet the demand for increased power output by increasing the plate voltage rather than by increasing the plate current. However, the plate voltage is fixed at a rather low value in new automobile receiver designs, and for this type of operation, the space-charge tetrode has a considerable advantage.

Normally, 10 to 15 milliwatts is sufficient power to drive an output transistor in audio *[sic]* radio receivers. The 12K5 is capable of delivering approximately 35 milliwatts at 10 per cent distortion into a load resistance of 800 ohms. Recently, the 12DS7, a twin-diode space-charge tetrode intended for low-voltage applications, was announced for detector automatic volume control - transistor driver applications. The space-charge tetrode unit of the 12DS7 is identical to that of type 12K5.

As mentioned previously, the beam power tube is more sensitive than a space-charge tetrode. Two to three times greater power sensitivity can be realized with a beam power design. However, the maximum power output is one-half that of a space-charge tetrode. In addition, the higher-sensitivity beam power tubes require an optimum load resistance three times that required for space-charge tetrodes.

REFERENCE

1. R. M. Matheson and L. S. Nergaard, "High Speed Ten-Volt Effect," *RCA Review*, Volume XII, pp. 258-268, June 1951.



TIMOTHY M. CUNNINGHAM served in the United States Navy from 1942 to 1947 in the field of communications. He received the B.S. degree in Electrical Engineering from Purdue University in 1951. Since 1951, he has been associated with the engineering section of the Electron Tube Division of RCA in Harrison, New Jersey. His work consists primarily of the design and development of receiving tubes. Mr. Cunningham is a member of Eta Kappa Nu.

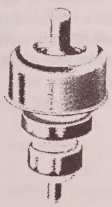
THE GE CERAMIC PLANAR-TRIODE LINE

Ludwell Sibley

General Electric developed a remarkable line of ceramic-bodied tubes with parallel-planar electrodes in the '50s-'60s. These had the feature of unusually small size and operation from audio to microwave frequencies. They gave short electron-transit time, another requirement for high-frequency performance. They could operate at high temperatures (175 to 250 ◦C) without forced-air cooling. They were said to survive high levels of nuclear radiation, both pulse and steady-state. Anodes were made of titanium or copper-titanium, which provides self-gettering of gases released within the tube. Their physical forms were optimized to fit, variously, resonant cavities and printed circuit boards. They had no place in entertainment electronics but were well suited to aerospace and military systems.

The tubes were products of GE's Microwave Products Division at its receiving-tube plant in Owensboro, Kentucky.

First in the line were the 6299 and 6442 triodes, registered in 1953-55. These led to numerous variant versions. None of the physical designs had bases like those of conventional tubes - some slipped into resonant lines or cavities; others were made of stacked ceramic rings with logs protruding from the sides. Some of these were held to a chassis or PC board with a T-shaped bolt. They were largely intended for grounded-grid amplifiers.



The 6299. The wide band is the grid terminal, for easy of grounding. Plate stud is at the top.

GE attempted to crack the market for UHF TV receivers with its 6BY4 triode of 1955, for use in RF amplifiers in tuners. UHF broadcasting was just getting started at the time. It suffered audience-wise from relatively low permissible transmitter power, a need for separate antennas on the receivers, and lack of sets that could receive the "new" channels without external converters. In TV "markets" where the FCC had assigned a mix of VHF and UHF channels, a UHF station was crippled in competition with the "V"s. The setmakers themselves were struggling to stay alive in a nasty competitive market. They greeted GE's proposal to spend more money on receivers with a profound yawn. (Sylvania tried to break into the UHF TV market the same year with its 6BA4 "rocket" triode. It flopped the same way.) The RCA Nuvistor was still some years away.

GE made another try to open a UHF market by bringing out two conventional miniature glass triodes, the 6AJ4 and 6AM4, but those were not well received either. As of 1961, these carried retail list prices of $9.80 and $5.90 respectively, well above the mass-market 6AF4 at $4.00.

GE registered 23 of its ceramic types between 1953 and 1964. An outlier, the 8751, came up in 1977. These were significant for high power at extraordinary frequencies (up to 9.6 GHz), low noise for receiving (a noise figure of only seven dB at 1 GHz), and survival under shock, vibration, and thermal stress. They gave pulse power outputs of 1.5 to 7 kW at 1 GHz. Besides the registered types, another 25 or so variants were offered under GE developmental codes (e. g., the Z-2731 half-wave power rectifier) and "GE" numbers like GE17241. Amplification factors for the triodes were high: The registered types gave 40 (the 8751) to 225 (the 7768). Transconductances ranged from modest (1.4 mS, for the 8081) to extraordinary (45 mS on the 7588). All but one had six-volt heaters.

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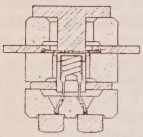
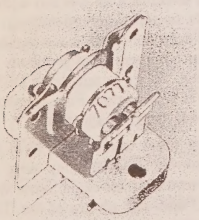
6442 (or 6771)

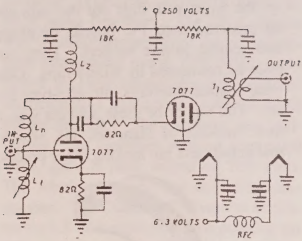
7077 promotion



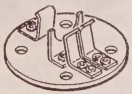
7077 outline



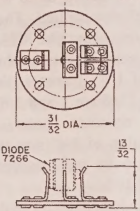
7077 in socket



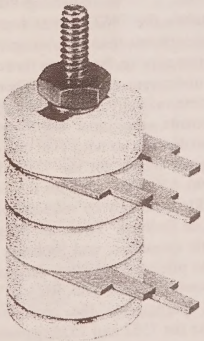
Cascode radar IF preamp using 7077s



PRINTBOARD SOCKET
FOR GE MICRO-MINIATURE
CERAMIC DIODE 7266



7266 in socket



7296

Besides mounting in coaxial RF circuitry, the types with lugs out the side could be soldered onto PC boards or plugged into special in-line sockets. They could even be connected by wire-wraps. Others were slipped sideways into clip-type holders. The maker of these sockets was Jetron Products of Hanover, NJ, which is still in business but making other products.

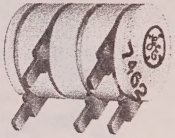
GE's 7486

GE kept the term "lighthouse" in use for some of these types, harkening back to its glass planar tubes of WW II. "Micro-miniature" also applied. They had no spiffy marketing name like RCA's "Nuvistor."

There were originally three groups of tubes: of 1/3" diameter (the7077 at al,), 1.2" (the 7768 etc.), and 5/8" (the Y-1238 and its cousins). Later developments yielded tubes of 3/4" size (the Y-1171 et al.) But there were exceptions like the tall, thin 6442.

The Nuvistor was an excellent tube in terms of microphonice, but GE was happy to publish a graph indicating that one of their tubes, the 7462, was at least 10 dB less microphonic than a Nuvistor.

In terms of price, the figures for early products underwent a reduction about 1955. "For these radically new high performance components, the most highly regarded electron devices we have ever introduced," the figures were: for the 7266, $14; for the 7296, $20; 7077, and for the 7486 and 7625, $16 (multiply by nine to convert to 2018 Lite Dollars). These are presumably in single quantities, and probably do not apply to pricing on military contract bids. One would suspect that RCA's "pencil" triodes, particularly the ceramic-bodied ones like the 7552 and 7554, gave GE significant competition. Similarly with RCA's Nuvistor products, for use at lower power and in easier environments.



The 7462 triode

A long-life version of the 6442 coded "DOD-018"was made for extra-life use in military transponders. An instruction slip packed with the tube read:

DETAIL INFORMATION SUBSTITUTING THE DOD-018 T/T FOR THE 6442 T/T

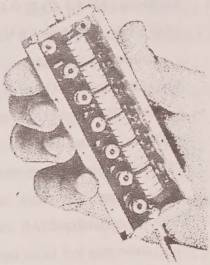
Reports from laboratory and operational TACAN system testing conducted jointly by the Naval Avionics Facility, Indianapolis, IN, and the GE Co., Owensboro, KY, indicated that the T/T DOD-018 life expectancy (3.000 hours; retail price $62.06) is 12 times that of the T/T 6442 (250 hours; retail price $16.48). The DESC, with Army and Air Force engineering approval for all systems and Navy approval limited to RT-547/ASQ and RT-793/ASQ, substitutes the DOD-018 for the 6442. This practice is based on detailed analysis which indicates that if only 1,000 hours of life are attained a significant savings will be achieved by you, our customer. Care should be taken not to replace the DOD-018 unless known to be defective. Also when repairing systems equipped with 6442(s), due to its short life you may find it economically feasible to replace all 6442(s) with DOD-018s to minimize operational failure and decrease future maintenance costs. Your comments and problems are solicited. Write or telephone DESC-SV, 1507 Wilmington Pike, Dayton, OH 45444, Autovon 850-5141.)

These tubes were said to have high reliability. GE claimed they were made in "their own hospital-clean Snow White facilities," although photos of the "line girls" do not show them wearing hair nets or oth-

er modern clean-room garb, only gloves. However, some special "AL"-suffixed items were offered for the airline trade.

The GE14811 competed, in the market for radar altimeters in the 4.3-GHz band, with small CW magnetrons like Raytheon's 6177 or Westinghouse's 7794. GE's products served in altimeters like the AN/APN-171.

The 7625 or 8081 audio tubes would have made a prestigious phono preamplifier.



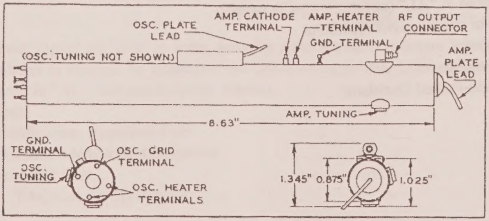
60-MHz radar IF strip using six 7462s in grounded-grid

Some of these tubes ran in the frequency - power domain of small klystrons, for example the Y-1171 operating at a remarkable 9.6 GHz.

Not well known today is an auxiliary product line from GE: a small line of MCMs: "microwave circuit modules." These were oscillators and amplifiers packaged in tubular metal cases with SMC coaxial fittings and tuning screws protruding.. They were comparable to a short series of "Functional Devices" (FD-2200, FD2201) made by RCA using Nuvistors. The GE C-2002A was an oscillator-amplifier for pulsed aircraft transponder use at 1090 MHz, introduced in 1969 (about the time that air-traffic-control transponders were required for all aircraft.) The oscillator was grid-pulsed. The amplifier, running from 1000 volts, gave a peak output of 700 watts. The whole assembly was cooled by conduction. The C-2063 MCM was an oscillator for 4.3-GHz altimeters incorporating the 16841 triode, intended for the receiver LO. The C-2064 MCM was a power oscillator, also for 4.3 GHz, using the 14811 tube. Fed by 500 volts, it gave 700-watt pulses.

GE closed its Owensboro operation in the late '80s. The Microwave Products Division was sold to a group of investors and became MPD, Inc. at the start of 1987. The company later diversified into other industries by acquisitions; however, the Web site of MPD Components Inc. offers essentially the same tubes as the GE line. They are nowadays named Vacuum Electron Devices (VEDs). MPD offers small magnetrons as well.

These tubes are highly collectible stuff. Our market-sensor agent Jim Cross advises that 7077s are the least rare and that 7486s are "thinkable." The 6BY4 is vanishingly rare, while the 7296, 7588, 7625, and 7720 are comparably unknown. There is a story of an ordinary TV servicing caddy turning up, with a supply of these tubes inside, and we once had a sprinkling of them in a TCA member auction.



C-2002A MCM oscillator-amplifier
Drawing: Emilio Ciardiello

REGISTERED TYPES

All are triodes except 7266 and 7841: diodes

Type	Registration & Date	Htr. Amps.	μ	G_m mS	Plate Diss., W	Fig.	Notes
6BY4	1529, 10-17-55	0.25	100	6.0	1.1	A	NF 8.5 dB @ 0.9 GHz
6299	1238, 9-18-53	0.3	115	15	2.0	B	Small-sig., NF 8.5 dB @ 1.0 GHz
6442*	1422, 2-28-55	0.9	50	16.5	6.0	C	4 GHz as PPO
6771	2386, 12-16-59	0.57	90	23	6.3	C	"Non-squegging" CW osc. or mult.
7077	2142. 3-31-58	0.24	90	10	1.1	D	Small-sig.; NF 5.5 dB @ 0.45 GHz
7266	2550, 8-3-59	0.215	-	-	-	E	UHF diode, volt. drop 1.0 V, 2.2 mA
7296	2550. 8-3-59	0.4	90	16.5	5.5		Bolt-mtd. power type
7391	2841. 6-13-60	0.38	62	11	2.25	B	6299 for Class C G-G osc.or amp.
7462.	2550, 8-3-59	0.24	94	10.5	1.1	F	Lug-mtd. 7077, osc. or low noise amp
7486*	2520. 7-6-59	0.24	90	10.5	1.0	D	7077 for pwr. osc./amp @
7588	2883, 7-18-60	0.4	175	45	5.5		UHF amp., side lugs, bolt-mtd.
7625	2724, 2-15-60	-0.215	80	1.4	0.85	F	Audio preamp., non-micro, lug-mtd.
7644	2755, 2-15-60	0.3	110	15	2.0	B	6299, pulse-stabilized G-G amp.
7720	3067, 12-12-60	0.24	90	10.5	1.0	F	Osc.; pulse amp to 3 GHz, lug-mtd.
7768	3547, 1-1-62	0.4	225	50	5.5	G	VHF-UHF amp., NF 3.0 dB @ 200 MHz
7784	3157, 2-13-61	0.3	110	15	2.0	H	6299 w/ isolated cathode "pinout"
7841	3098, 2-13-61	0.215	-	-		E	7266, drop held to 0.6 V, 5.0 mA
7910	4458, 10-21-63	0.275	75	16	7.5	J	Plate-pulsed osc. to 7.5 GHz
7911	4845, 11-9-64	0.55	58	25	6.5	R	Plate-pulsed osc. to 6 GHz
7913	4548, 12-30-63	0.4	100	40	5.5	G	CW amp. or osc. to 0.4 GHz
8081	3406, 9-4-61						T-bolt version of 7625
8082	3406, 9-4-61						T-bolt version of 7720
8083	3406, 9-4-61						T-bolt version of 7462
8751	6693, 8-9-77	1.06	40	28	30	L	PPO or driver, cooling stud

* Also offered in "AL" (airline) long-life version

@ Tested for use as pulsed oscillator

Abbreviations:

NF: Noise Figure

PPO: Plate-Pulsed Oscillator

NONREGISTERED TYPES

"Production" types, 1974. All are triodes.

Type	Htr. Curr.	Plt. Diss. Watts	Max. Freq. GHz	Typical Output Watts @ GHz	Duty Factor	Fig.	Notes
GE12661	0.24	4.0	3.0	6.0 @ 0.45	CW	M	Low input to grid-plate capacitance ratio
GE13971	0.55	6.5	6.0	1000 @ 1.1	.004	N	G-G version of 7911
GE14501	0.24	1.0	7.5	0.3 @ 1.2	CW	P	Coaxial oscillator
GE14811	0.38	6.5	6.0	190 @ 4.3	.001	R	Smaller-area 7911 for radar altimeters
GE15371*	0.5	10	6.0	700 @ 1.1	.01	S	IFF and DME power amp.
GE15375*	3.5 W	10	4.5	1000 @ 1.1	.004	K	IFF and DME power amp.
GE16231*	0.4	6.5	3.0	100 @ 1.1	.004	G	High-gain broadband pulsed amp
GE16411	0.15	1.0	7.5	0.45@ 0.45	CW	J	7486 with bonded heater
GE16841	0.275	1.5	7.5	- @ 4.3	CW	J	CW oscillator
GE17701	1.25	30	3.0	2500 @ 1.1	.004	L	Power amp. for TACAN / DME
GE18651^	0.5	6.5	6.0	1000 @ 1.1	.001	T	GE13971 with extended anode; PPA.
GE21351	3.2W	10	6.0	500 @ 1.1	.004	S	TACAN / DME power amp.
Y-1032	1.5W	1.0	6.0		CW	P	Low-voltage 7077 - 60 Vmax.
Y-1124	1.4W	3.5	6.0	40 @ 5.7	.016		Bonded-heater 7910; 400 V max.J
Y-1171	1.7W	4.5	10.0	.01 @ 9.6	CW	U	X-band CW oscillator
Y-1223	2.8W	30	2.5			J	High-diss. 7913; 600 V max.
Y-1251	1.5W	2.5	6.6	.02 @ 5.9	CW	J	C-band osc; 200 V max..
Y-1530	0.500	6.5	3.0				Bonded-heater version of the 7768
Y-1540	0.400	30	3.0			X	High-dissipation version of the 7768
Y-1541	3.8W	6.5	6.0	600 @ 4.3	.001	R	Grid-pulsed, bonded htr.
Y-1549	3.5W	6.5	6.0	600 @ 4.3	.001	R	Grid-pulsed 7911
Y-1610	0.15	1.0	7.5	0.3 @ 1.2	CW	R	10=-volt version of the GE14501
Y-1636	8.2	50	3.0	1000 @ 2.0	.007	V	Pulsed oscillator
Y-1692	7.8W	50	2.5	50 @ 1.0	CW	W	High-Gm, low-volt.Y-1636, 600 V max.
A-0913							7913 selected for high emission and Gm

Some heater inputs are listed in watts, possibly from the need to reduce heater power at high frequencies to account for heating of the cathode due to back-bombardment.

* Also offered in "AL" (airline) long-life version.

Abbreviations:

IFF - Identification, Friend-or-Foe
DME: Distance-Measuring Equipment
G-G: Grounded Grid
TACAN: TACtical Air Navigation

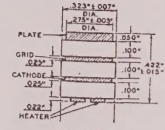
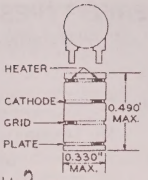


Fig. A
(6BY4)



7462
Fig. F
(7642)

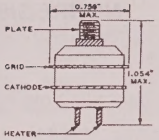


Fig. L
(GE17701)

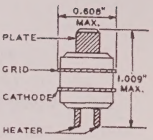


Fig. S
(GE15371)

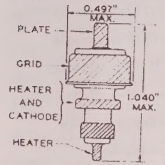


Fig. B
(6299)

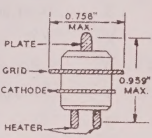


Fig. G
(GE16231)

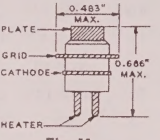


Fig. M
(GE12661)

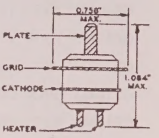


Fig. T
(GE18651)

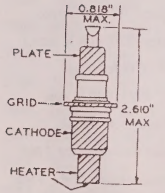


Fig. C
(6442)

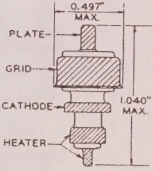


Fig. H
(7784)

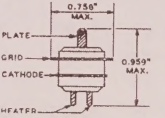


Fig. N
(GE13971)

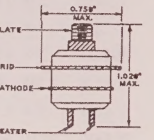


Fig. U
(Y-1171)

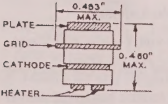


Fig. D
(7077)

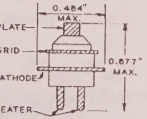


Fig. J
(7910)

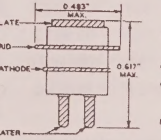


Fig. P (GE14501)

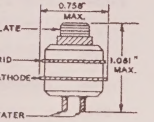


Fig. V
(Y-1636)

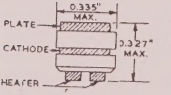


Fig. E
(7266)

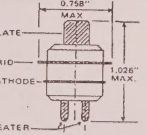


Fig. K
(GE15375)

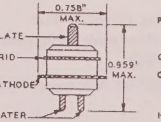


Fig. R
(GE14811)

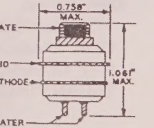


Fig. X
(Y-1602)

NEW METAL-AND-CERAMIC "MICRO-MINIATURE" TUBES

National TV-Radio News, Dec. 1954 - Jan. 1955

Via www.americanradiohistory.com, scouted by **Jiri Placek**

WASHINGTON, D. C. - A radical new concept in receiving tube design has been announced by General Electric and demonstrated in the form of a tiny "micro-miniature" ceramic triode for UHF television sets.

The micro-miniature triode - 6BY4 - is an all metal-and-ceramic tube about three-eighths of an inch long and five-sixteenths of an inch in diameter. Preliminary ratings on this particular tube are based on an operating frequency of 900 megacycles. Development work at the G. E. Receiving Tube Sub-Department in Owensboro, Ky., indicates production models soon will be available with a noise factor of approximately eight decibels, and a power gain of approximately 15 decibels when operating at this frequency with a bandwidth of 10 megacycles.

While the tube cathode normally is heated with a filament in the conventional manner, a startling demonstration with a blow torch applied to the outside of the tube showed how it also will operate when heated by an external source.

G-E engineers see the possibility of a complete line of these tiny electronic tubes from diodes to complex multi-element tubes. Possible applications include mobile and industrial communications, airborne and mobile radar, industrial controls, guided missile controls, nuclear power controls - possibly even man-made satellites.

"In general, any electronic equipment requiring motion, high temperature, restricted space, automatic assembly or UHF performance has a potential requirement for micro-miniature tubes," according to Mr. J. M. Lang, GE's tube department manager.

"The design and manufacture of micro-miniature ceramic tubes represents a complete departure from conventional techniques of quantity tube manufacture," said Lang. "New materials, processes and assembly methods were necessary to produce tubes such as the 6BY4.

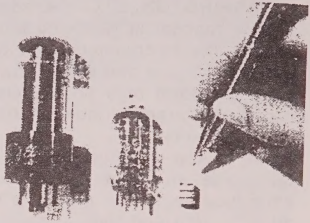
"The grid assembly is typical of this fresh approach. This grid is made from tungsten wire only .0003 of an inch in diameter - so fine it is virtually invisible under normal room lighting. Nevertheless, the wire is wound and brazed to a small tungsten washer at a pitch of 1000 turns per inch - representing a new degree of precision in quantity tube manufacture. Special machinery developed by G-E engineers performs this delicate operation.

"Extensive ceramic research was necessary to develop the material used for spacers in this tube. The search for a low-loss ceramic of appropriate expansion characteristics, dimensional stability and vacuum tight sealing characteristics requires investigation of materials not previously used in vacuum tube manufacture.

"The exhaust and sealing techniques used in the production of these tubes are unique in the field of vacuum tube manufacture. The resulting seals remain vacuum-tight at temp-

eratures in excess of 700 degrees Centigrade.

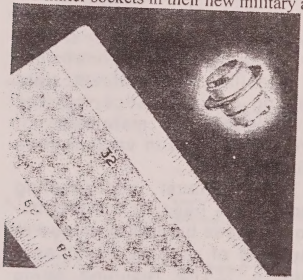
"The development of the 6BY4 and subsequent ceramic micro-miniature receiving tubes transcends the art of designing electrical tube characteristics. It embraces research in metals and ceramics, development of new exhaust and sealing techniques, design of new tube-making machinery and investigation of new processing methods. The result is a tube of completely new construction and greatly improved physical and electrical characteristics.



SIX 7077 CERAMIC TRIODES USED IN RF STAGE OF COLLINS ARC-52 MILITARY COMMUNICATIONS SYSTEM

From General Electric Tube Design News, *apparently dating from 1959 as judged from another article in the same issue. - Ed.*

Low noise, high gain, exceptionally small size - these qualities of General Electric's 7077 were responsible for Collins Radio Company's choice of the tube for RF amplifier and mixer sockets in their new military airborne communications equipment.



Now in production, Collins' advanced system meets the needs of the newest, fastest planes because of its communications range, compact size, and ability to stand up in hard service. The tough metal-ceramic construction of Type 7077 contributes to the ARC-52's ruggedness.

This actual-size picture of the G-E 7077 shows the triode's small dimensions - only .44" long by .48" wide. Extreme compactness was one reason Collins specified Type 7077. *(GE had registered the 7077 in 1958. The ARC-52 covered 225-400 MHz and was used in, for example, the F-104 fighter. - TCA Ed.)*

WEIRD TUBE OF THE MONTH

RCA'S R-2061

Here's a "lost" tube: the R-2061 planar radar triode. Joseph Fetsch, a civilian employee of the U. S. Navy at the Brooklyn Navy Yard and official consultant on tube matters, asked RCA in 1954 for information on this tube, of which he had two samples. Gene Rivers of the Harrison location replied on Nov. 22 with the following information:

Leon S. Nergaard, the designer of this type and now with the David Sarnoff Research Center of Princeton recognized it as one he developed under an NRL *([Naval Research Laboratory]* contract, No. 74785, dated 29 June 1940.

The data you requested is as follows:

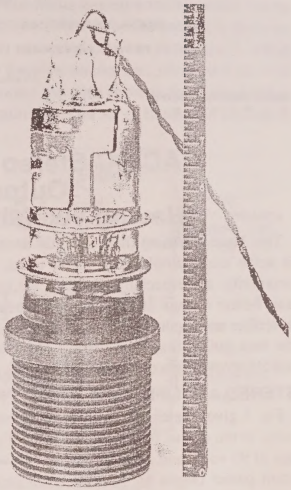
Year of design origin:	1940
Development No.:	R-2061
Kind of tube:	Pulse triode
Ratings:	
Frequency	600 Mc
Peak power output:	20 kw
Pulse length:	2 microseconds
Duty:	1 per cent
Max. plate voltage:	15 k.v.
Cooling:	Air
Purpose:	Search radar
Special features:	Disc seals

There was never any equipment use made of this tube as far as we know. It was later superseded by the A-2212 which became the RCA type 4C33 and with which you are familiar. I am sending an HB-3 data sheet on the 4C33.

The R-2061 was declassified on 12 August 1948.

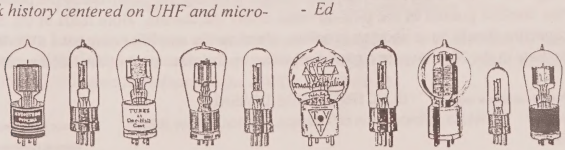
/s/ Gene Rivers

Dr. Nergaard was a physicist whose work history centered on UHF and microwave tubes. He participated heavily in IRE committees and standards groups on electron devices, and was elected to Fellow grade in 1952. Late in his career he was the Director of the Microwave Research Laboratory of RCA Laboratories.



"R" development numbers at RCA normally applied to rectifiers and thyratrons. In a prowl of RCA's development files leading to TCA Special Publication 19 ("Index of RCA Developmental and Commercial Type Numbers"), there was a wide gap between R-661 (a redesigned Type 80) and R-6001 (the commercial 12Z3).

Original letter courtesy of Jerry Vanicek - Ed



RCA MANUFACTURING COMPANY, INC.
A RADIO CORPORATION OF AMERICA SUBSIDIARY
Harrison, New Jersey

RCA RADIOTRON
DIVISION

AN-190

AC/DC Stereo Amplifiers Using Output Tubes Having 100-Milliampere Heaters

This Note discusses three recently developed power-output tubes and their application in ac/dc stereo amplifiers. These tubes, which are miniature types having high power sensitivity, are especially designed for use in series-heater-string circuits operating at a total heater voltage of 120 volts and a heater current of only 100 milliamperes. The Note describes and evaluates the performance of three series-string stereo amplifiers utilizing the new 100-milliampere tubes. These amplifiers, utilizing types 34GD5, 50FK5, and 60FX5, provide maximum power outputs ranging from 1.0 to 1.25 watts per channel.

STEREO AMPLIFIER UTILIZING TYPE 34GD5

Fig. 1 gives the circuit of an ac/dc stereo amplifier employing two 34GD5 beam power tubes in the output stages. At a plate voltage of 114 volts, a screen-grid (grid-No.2) voltage of 99 volts, and a peak grid-No.1 drive of 6.8 volts, each 34GD5 can provide a maximum power output of 1.0 watt at 10 percent total distortion to a 4-ohm voice coil. A peak input signal to each channel of 180 millivolts is required for maximum power output. The first column of Table I lists measured average operating characteristics for each output tube in this amplifier.

The circuit shown in Fig.1 is, essentially, a conventional resistance-coupled amplifier. Some special construction practices are necessary, however, as a result of the series-string arrangement. Because there is no transformer isolation in the amplifier, for reasons of safety the negative side of the power supply should be isolated from the chassis by means of a capacitor. This capacitance between B- and the chassis should not be greater than 0.1 microfarad. Although values as low as 0.03 microfarad cause no significant loss of gain from the cartridge input, hum pickup increases with low values of capacitance. When a 0.03-micro-farad capacitor is used, for example, the ac voltage between the chassis and B- is approximately 3 volts peak-to-peak. This voltage is picked up and amplified by the 20EZ7 and appears as an ac hum at the speakers.

Use of a 0.1-microfarad capacitor reduces this hum voltage to about 1 volt peak-to-peak.

Placement of the isolation capacitor is critical. One lead should be connected to the low-voltage end of the 20EZ7 cathode-bias resistor at B- and the other lead to the point at which the shielded ground of the pick-up cable enters the chassis. Both leads of the isolation capacitor should be as short as possible. Because the amplifier may have a tendency to oscillate in the 20-kilocycle region depending on the placement of the isolating cap-

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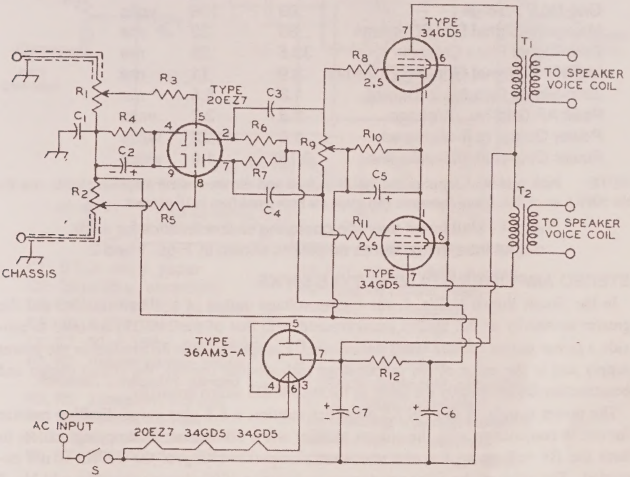
acitor, a 10,000-ohm resistor in series with the control grid of each of the 34GD5s is used to suppress possible oscillations.

The 36AM3-A rectifier tube incorporates a tapped heater having a section which can be used as a surge limiter and fuse for the B+ supply. This 4-volt fuse section is between pins 4 and 6. The 32-volt section of the heater is connected between pins 6 and 3. Pin 6 should be tied directly to the line input. When the plate connection, pin 5, and pin 4 of the heater are connected together, ac voltage reaches the plate through the 4-volt section of the heater. This arrangement meets safety requirements for surge limiting in half-wave ac/dc rectifiers tied directly to the ac power line.



C1: 0.1 µf, 200 v., paper
C2: 25 µf, 25 v., electrolytic
C3, C1: 0.047 µf, 150 v., paper
C5: 50 µf, 25 v., electrolytic
C6, C7: 50 µf, 150 v., electrolytic
R1, R2: Volume control, potentiometer, 1 megohm, ganged
R3, R5: 1 megohm, 0.5 watt
R10: 3300 ohms, 0.5 watt
R6, R7: 220,000 ohms, 0.5 watt
R8, R11: 10,000 ohms, 0.5 watt
R9: Balance control, potentiometer, 0.5 megohm
R10: 68 ohms, 1 watt
R12: 1500 ohms, 2 watts
S: Switch; single-pole, single-throw
T1, T2: Output transformer for matching impedance of voice coil to 3000-ohm tube load (Stancor A-3825 or equivalent)

Fig. 1 -Stereo amplifier utilizing 34GD5 beam power tubes.

The two 1-megohm volume controls should be ganged on a single shaft to simplify balance. If desired, tone controls can be added to the circuit. Any output transformer providing 2500 ohms impedance to the 34GD5 may be used.

Because the gain of the amplifier is not sufficient to make external-hum pickup critical, use of a cover for the bottom of the chassis is not necessary. The unshielded bottom of the amplifier chassis should not, however, be placed in the magnetic field of an ac turntable motor. For minimum hum in the driver stage, the heater of the 20EZ7 should be placed at the "cold" end of the string. Heater pin 1 of the 20EZ7 should be tied to B- at the same point at which the cathode-bias resistor, the isolating capacitor, and the common-ground shield of the cartridge lead are tied.

	34GD5	50FK5	
Plate Voltage	114	124	volts
Grid-No.2 Voltage	99	109	volts
Maximum-Signal Plate Current	33	32	ma
Zero-Signal Plate Current	33.5	28	ma
Maximum-Signal Grid-No.2 Current	3.9	11	ma
Zero-Signal Grid-No.2 Current	1.8	8.5	ma
Peak AF Grid-No.1 Voltage	6.8	3.2	volts
Power Output to 4-ohm load	1.0	1.25	watts
Power Output at 105 volts line	0.75	1.0	watts

NOTE: Peak grid-No.1 input to the 20EZ7 is 0.18 volt for the 34GD5 amplifier; 0.092 volt for the 50FK5 amplifier. Total harmonic distortion for both amplifiers is 10 percent.

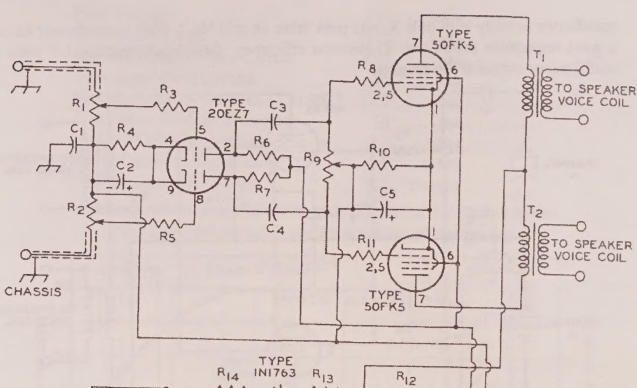
Table I - Measured average operating characteristics for each output tube in the stereo amplifiers shown in Figs. 1 and 2.

STEREO AMPLIFIER UTILIZING TYPE 50FK5

In the circuit shown in Fig. 2, the higher voltage output of a silicon rectifier and the greater sensitivity of the 50FK5 (as compared with that of the 34GD5) are used to provide a power output of 1.25 watts per channel. Except for some differences in the power supply and in the value of the output-stage cathode-bias resistor, the circuit design and construction are essentially the same as for the 34GD5 stereo amplifier.

The power supply of the 50FK5 amplifier requires a 6.8-ohm surge- limiting resistor for use in conjunction with the silicon rectifier and a 50-ohm series dropping resistor to limit the B+ voltage so that the maximum dissipation rating of the 50FK5 is not exceeded. The value of the filter resistor was reduced to 1000 ohms to raise the grid-No. 2 and plate-supply voltage of the 20EZ7 high enough so that the maximum total distortion does not exceed 10 percent.

The second column of Table I lists measured operating characteristics for each output tube in this amplifier. Fig. 3 gives average curves of power output and distortion as functions of frequency for both the 34GD5 and 50FK5 amplifiers.



C1: 0.1 µf, 400 v., paper
C2: 25 µf, 25 v., electrolytic
C3, C1: 0.047 µf, 150 v., paper
C5: 50 µf, 25 v., electrolytic
C6, C7: 50 µf, 150 v., electrolytic
R1, R2: Volume control, potentiometer, 1 megohm, ganged
R3, R5: 1 megohm, 0.5 watt
R4: 3300 ohms, 0.5 watt
R10: 3300 ohms, 0.5 watt
R6, R7: 220,000 ohms, 0.5 watt
R8, R11: 10,000 ohms, 0.5 watt
R9: Balance control, potentiometer, 0.5 megohm
R10: 33 ohms, 1 watt
R12: 1000 ohms, 2 watts
R13: 50 ohms. 1 watt
S: Switch; single-pole, single-throw
T1, T2: Output transformer for matching impedance of voice coil to 3000-ohm tube load (Stancor A-3825 or equivalent)

Fig. 2 -Stereo amplifier utilizing 50FK5 power pentodes.

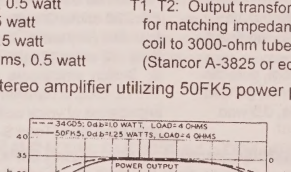
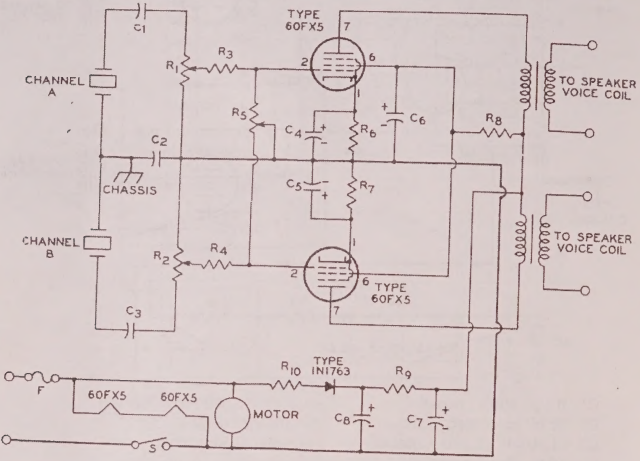


Fig.3 - Power output and total harmonic distortion as functions of frequency for the stereo amplifiers shown in Figs. 1 and 2.

LOW-COST PORTABLE STEREO AMPLIFIER UTILIZING TYPE 60FX5

Fig. 4 gives the circuit of an ac/dc portable stereo amplifier employing two 60FX5 power pentodes. In stereo units utilizing high-output low-cost ceramic stereo cartridges, the high power sensitivity of the 60FX5 at low supply voltages eliminates the need for a preamplifying stage. The 60FX5 provides a power output of 1.3 watts to a 3000-ohm

transformer primary with only 3 volts peak drive on grid No. 1. With a transformer having a good impedance match and 85-per-cent efficiency, this circuit supplies 1.1 watts of useful power output at the speaker.



C1, C3: 0.022 µf, 400 v., paper
C2: 0.1 µf, 400 v., paper
C4: C5: 50 µf, 25 v., electrolytic
C6: 50 µf, 150 v., electrolytic
C7, C8: 50 µf, 150 V., electrolytic
F: Fuse, 3 amperes
R1, R2: Volume control, potentiometer, 1.5 megohms, ganged
R3, R4: 47,000 ohms, 0.5 watt
R5: Balance control, potentiometer, 2 megohms
R6, R7: 60 ohms, 1 watt
R8: 220 ohms, 2 watts
R9: 280 *[sic]* ohms, 2 watts
R10: 12 ohms, 1 watt
S: Switch; single pole, single throw
T1, T2: Output transformer for matching impedance of voice coil to 3000 ohm tube load (Triad S-16X or equivalent)

Fig. 4 -Low-cost portable stereo amplifier utilizing 60FX5 power pentodes.

No special mounting or layout precautions are necessary for this amplifier other than the value and placement of the isolating capacitor between B- and the chassis. This capacitor should be connected to the same point on the chassis to which the common cartridge lead is tied. A value of 0.1 microfarad for the isolating capacitor is suggested so that full output is obtained from the pickup.

As with all single-ended amplifier circuits, especially ac/dc units, adequate screen-grid bypassing is necessary to minimize hum. Screen-grid filtering is obtained through use of a 220-ohm dropping resistor and a 50-microfarad electrolytic capacitor. Although separate cathode-bias resistors are used for better dynamic balance in the circuit shown, a single 30-ohm common cathode-bias resistor bypassed with a 50-microfarad electrolytic capacitor may also be used.

Measured operating conditions for each 60FX5 are listed in Table II; curves of power output and total distortion as functions of frequency are shown in Fig. 5.

Plate Voltage	111	volts
Grid-No.2 Voltage	112	volts
Maximum-Signal Plate Current	32.5	ma
Zero-Signal Plate Current	36	ma
Maximum-Signal Grid-No.2 Current	13.5	ma
Zero-Signal Grid-No.2 Current	10	ma
Peak AF Grid-No.1 Voltage	2.7	volts
Power Output to 4-ohm load	1.1	watts
Total Harmonic Distortion	9.3	percent

Table II -Measured operating characteristics for each 60FX5 in the low-cost portable stereo amplifier shown in Fig. 4.

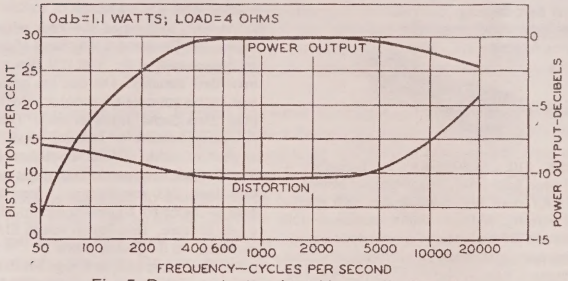


Fig. 5 -Power output and total harmonic distortion as functions of frequency for the 60FX5 amplifier.

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OLD NEWS

TELEVISION RENTAL BY ALERT RADIO SERVICE DEALER

The *Photofact Servicer*, Feb. 14, 1958

While at the Philadelphia Town Meeting, we learned of a method of television sales which may be quite interesting to our patrons. The Great Neck Electric Company of Great Neck, Long Island, is providing rental of television sets for parties at a price of $35 per evening, which includes temporary installation, doublet antenna, lineup, and tuning of the set prior to the party. They currently have five receivers and have turned down requests every time a major television event occurs, such as a championship prize fight, football game, or World Series baseball game. The rentals have in almost all instances produced at least one new television sale to a guest at the party, if not to the person throwing the "shindig." Of course, this is possible in Great Neck without the necessity of erecting a high antenna, due to the fact that it is a residential community, far enough from New York to be free of multi-path ghost problems.

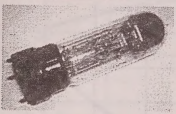
WANT ADS

Ads are offered for TCA members' (and nonmembers') convenience, in parallel via the bulletin and the club's Web site. We expect ads to be related to tube collecting / history / use and noncommercial in nature. We may reject any not meeting this standard and may edit ads for space. Ads may be emailed to n6jv@n6jv.com or mailed physically to Ludwell Sibley at 102 McDonough Rd., Gold Hill, OR 97525-9626.

Print ads "time out" after a year, so to continue an ad (or reinstate an old one), please advise.

FOR SALE

Loewe 3NF three-stage amplifier, original, all filaments good, to be sent worldwide by Fedex, insured, US$2000,. Shipped insured up to US$2500 within the value of the shipment. Buyer pays shipping. Abel Santoro, Argentina. Abelsantoro56@gmail.com. *(new4-17)*



Books: THE CATHODE-RAY TUBE (Keller), a 314-page, hard-cover, comprehensive history of the CRT from 1991 with approx. 300 photos and drawings and extensive references to 100 years of CRT literature. Covers television, oscilloscope, radar, avionics, photorecording, and computer CRTs. WINNING WITH PEOPLE: THE FIRST 40 YEARS OF TEKTRONIX (Lee), 326-page hardcover, 1986. Prepaid price for either $69.50 ($62.50 to TCA members) + $6 S/H in the US. Peter A. Keller, 7445 SW Bayberry Dr., Aloha, OR 97007, kellerp4@ frontier.com.

Book "History of GEC and the Marconi Osram Valve" (Stewart). Published in 1996 and revised in 2005, this work is available as a CD / PDF file. The book is in two parts - 1) a history of the company and 2) history of development of the tubes from WW1 to around 1970. Many photos, adverts and data listings, together with tube equivalent listings. Total of 132 pages. $A 20 including air mail postage. Payment by PayPal preferred. Fin Stewart, 38 Primrose St Wingham NSW 2429 Australia. Email ferrowatte38@bigpond.com.

TCA Data Cache - a two-DVD-ROM set offers three elements:

(A) Scans of about 4000 pages of RCA internal Product-Management files on ca. 2800 tube types, mostly "Harrison" receiving types but with some "Lancaster" devices as well;

(B) About 7000 "registration release" records from the Joint Electron Devices Engineering Council of the RMA / EIA, from the beginning in 1933 until "modern" times;

(C) A 43-image step-by-step "photo shoot" from Eitel-McCullough Inc. on 1944 production of the VT-158 "Zahl" radar oscillator tube.

The RCA information is from a series of 37 two-inch binders in the Dowd-RCA archive, a holding of the AWA Museum.

The EIA contributed the data without an index. Jim Cross and a jolly band of researchers opened each of the 7000 PDF files to determine their contents. The disc has comprehensive indices covering tubes and semiconductors. (The "Data Cache" is not termed a "*Tube*" data repository because it includes about 17,000 entries on semis, 1N21B through 6N104A.) The EIA releases provide data sheets on products from 243 manufacturers, domestic and foreign. Some are household names; others are totally obscure. Distribution was to EIA/RMA members, not the general public.

The discs come with an 8-page booklet covering the capabilities and limitations of the files.

Price: $50 postpaid anywhere. Use of PayPal is welcome. See inside front cover for address.

WANTED

Wish to correspond w/ members about their experiences with Geiger Counters. I have recently restored a couple of instruments from the late '40s, as well as an instrument supplied by HEATHKIT (Imagine that!!!). I'd like to hear about members' trials and tribulations, hints, as well as their acquisition(s) of the rare Geiger-Mueller tubes. Please snail-mail, email or call. Stephen Imms, 1481 Lynda Ave., Clarkdale, AZ 86324, steveimms@cableone.net, (928) 852-0881 *(New 10-17)*

The following tube testers: Weston 978, Weston 686-10, Weston OD-3, Weston OD-7, RCA W-100 Series 3, New London 901A, Hickok 700 / 1700. Stewart Kleinschmidt, 847-392-6257, kes502@aol.com.

Always looking for different transmitting tubes for the Virtual Transmitting Tube Museum. Tubes don't need to be good, but photogenic would be nice. More common types needed include the 100TL and HK354F as well as the less common 100TS, HK-1054, HK-3054 and the 500T. Norm Wilson; n6jv@n6jv.com.

OLD-TIME PROMOTION

PUBLIC INFORMATION *from*

Hygrade Sylvania
CORPORATION

#3-116

PRESS RELATIONS BUREAU • • • • 500 Fifth Avenue • • • • New York City • • • • Chickering 4-4470

RLEASEUPON RECEIPT

Photo of Hammered
Tube Test on request

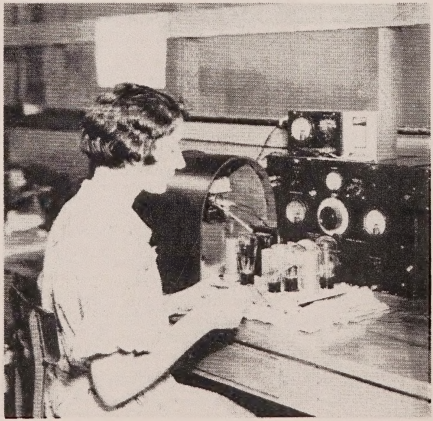
HAMMERED TUBES

What does it mean? Just what the term implies, and, like hammered silver, a thing of beauty, in this case rare tone.

The visitor to the huge Sylvania radio tube plant at Emporium, Pa., is bound to be impressed by the large number of girl operators working with tiny hammers, knocking tubes from morning till night. In different parts of the plant, as the tubes are checked and rechecked, the hammering goes on until tubes are packed for final shipment. Why all this hammering?

The answer is noise testing. It seems that when superheterodyne receivers were first introduced, tube noise suddenly loomed up as a dominating factor. Radio receivers today are so sensitive that tube noise or background noise traceable to tube imperfections must be reduced to the irreducible minimum. Hence all Sylvania tubes are noise tested.

Each tube is subjected to a noise test in a radio receiver especially sensitive to tube noises of all kinds. Out on the factory floor, close to the intricate machines producing the tubes, gir! noise-testers work in virtual bird cages - wire screen booths which shield the sensitive radio sets from the interference of nearby high-frequency bombarders or induction heaters on the exhaust units. As each tube is placed in the noise testing set, the operator listens to the loud-speaker for any hissing or swishing noises, and then strikes the tube several times with a hard rubber hammer, listening intently each time for any signs of loose connections, shorts or other microphonic troubles. Tubes are also subjected to hammer blows in testers provided with neon lights, the altered glow of which indicates loose connections, shorts or other defects.



A letter transmitting this release indicates 1934 vintage. The radio chassis rests on sound-insulating material. The large black box looks like a General Radio signal generator. The wall appears to be covered in wire screen - the radio-noise environment inside the plant must've been awful, with multiple quenched-spark-gap bombarders going.

RADIO